

REMARKS

Favorable reconsideration of this application in light of the following discussion is respectfully requested.

Claims 1-37 are currently pending. No claims have been amended herewith.

In the outstanding Office Action, Claims 1-7, 15-24, 27-35, 36/1-36/7, 36/15-36/24, 36/27-36/35, 37/1-37/7, 37/15-37/24, and 37/27-37/35 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,490,476 to Townsend et al. (hereinafter “the ‘476 patent”) in view of Lin et al. (“An Application of Convolution Neural Networks: Reducing False-Positive in Lung Nodule Detection”) (hereinafter “the Lin et al. reference”); and Claims 8-14, 25, 26, 36/8-36/14, 36/25, 36/26, 37/8-37/14, 37/25, and 37/26 were objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form.

Claim 1 is directed to a method for the automated detection of lung nodules in computed tomography (CT) image scans, comprising: (1) generating two-dimensional segmented lung images by segmenting a plurality of two-dimensional CT image sections derived from the CT image scans; (2) generating three-dimensional segmented lung volume images by combining the two-dimensional segmented lung images; (3) determining three-dimensional lung nodule candidates from the three-dimensional segmented lung volume images, including identifying structures within the three-dimensional segmented lung volume images that meet a volume criterion; (4) deriving features from the lung nodule candidates; and (5) detecting lung nodules by analyzing the features to eliminate false-positive nodule candidates from the nodule candidates.

Regarding the rejection of Claim 1 under 35 U.S.C. § 103, the Office Action asserts that the ‘476 patent discloses everything in Claim 1 with the exception of detecting lung

nodules by analyzing derived features to eliminate false-positive nodule candidates, and relies on the Lin et al. reference to remedy that deficiency.

The ‘476 patent is directed to a method for acquiring PET and CT images sequentially in a single device to overcome alignment problems due to internal organ movement and variations in the position of a patient. Further, as shown in Figure 3, the ‘476 patent discloses a method for displaying a “fused” PET and CT image. In addition, the ‘476 patent discloses that “a 3D display computer” may be used to offer “interactive 3D shaded graphics of anatomical structures,” which can be displayed as shaded surfaces within the image.¹ However, Applicants respectfully submit that the ‘476 patent fails to disclose (1) generating *three-dimensional segmented lung volume images* by combining two-dimensional segmented lung images; (2) determining three-dimensional lung nodule candidates from the three-dimensional segmented lung volume images, including identifying structures within the three-dimensional segmented lung volume images; and (3) deriving features from the three-dimensional lung nodule candidates. Further, as admitted in the Office Action, the ‘476 patent fails to disclose detecting lung nodules by analyzing features to eliminate false positive nodule candidates from the nodule candidates.

Regarding the generation of a three-dimensional segmented lung volume image, the ‘476 patent merely discloses that *entire* CT scans may be visualized in a conventional manner using a 3D display computer. However, the ‘476 patent does not disclose that two-dimensional segmented lung images are combined to form a three-dimensional segmented lung volume image that is subsequently used as part of an automated nodule detection method, as recited in Claim 1.

Regarding the step of determining three-dimensional lung nodule candidates from a three-dimensional segmented lung volume image based on a volume criteria, the ‘476 patent

¹ Column 14, lines 31-43 of the ‘476 patent.

does not disclose the use of a three-dimensional segmented lung volume image for the automated detection of nodule candidates. In particular, Applicants note that the passage in the ‘476 patent cited by the Office Action relates merely to the estimation of a volume missing from a scan, which is then added to the CT image.² However, Applicants submit that this disclosure is unrelated to determining *three-dimensional lung nodule candidates* in a three-dimensional segmented lung volume image, as recited in Claim 1.

Further, since the ‘476 patent fails to disclose determining lung nodule candidates, it also must fail to disclose deriving features from the lung nodule candidates. Further, Applicants note that the passage in the ‘476 patent cited by the Office Action relates only to a three-dimensional visualization method and is unrelated to deriving features of lung nodule candidates identified within three-dimensional segmented lung volume images, as recited in Claim 1.

The Lin et al. reference is directed to a convolution neural network (CNN) for the detection of lung nodules on digital chest radiographs using pre-processed image pixels as inputs. The Lin et al. reference discloses that, as is generally true, the goal of any computer-aided diagnosis (CADx) scheme is to increase the true-positive fraction while decreasing the false-positive fraction of the CADx scheme. However, Applicants respectfully submit that the Lin et al. reference fails to disclose a generating *three-dimensional segmented lung volume images* by combining two-dimensional segmented lung images; (2) determining three-dimensional nodule candidates from the three-dimensional segmented lung volume images, including identifying structures within the three-dimensional segmented lung volume images; and (3) deriving features from the lung nodule candidates. Moreover, the Lin et al. reference’s discussion regarding the goal of reducing false-positive is not a disclosure of detecting lung nodules by analyzing features to eliminate false-positive nodule candidates, as

² See column 22, lines 3-19 of the ‘476 patent.

recited in Claim 1. In fact, the Lin et al. reference fails to disclose the use of any derived features in detecting lung nodules.

Thus, no matter how the teachings of the '476 patent and the Lin et al. reference are combined, the combination does not teach or suggest (1) generating three-dimensional segmented lung volume images, (2) determining three-dimensional lung nodule candidates from the three-dimensional segmented lung volume images, (3) deriving features from the lung nodule candidates, and (4) detecting lung nodules by analyzing the derived features to eliminate false-positive candidates, as recited in Claim 1. Accordingly, Applicants respectfully submit that a *prima facie* case of obviousness has not been established and that the rejection of Claim 1 (and dependent Claims 2-7 and 15) should be withdrawn.

Claims 16, 20, 24, 28, and 32 recite limitations analogous to the limitations recited in Claim 1. In particular, Applicants note that Claims 16, 20, 24, 28, and 32, each recite the step of generating three-dimensional segmented lung volume images by combining two-dimensional segmented lung images. Accordingly, for the reasons stated above for the patentability of Claim 1, Applicants respectfully submit that a *prima facie* case of obviousness has not been established and that the rejection of Claims 16, 20, 24, 28, and 32 (and all associated dependent claims) should be withdrawn.

Thus, it is respectfully submitted that independent Claims 1, 16, 20, 24, 28, and 32 (and all associated dependent claims) patentably define over any proper combination of the '476 patent and the Lin et al. reference.

Application No. 09/759,333
Reply to Office Action of March 29, 2004.

Consequently, in light of the above discussion, the outstanding grounds for rejection are believed to have been overcome. The present application is believed to be in condition for formal allowance. An early and favorable action to that effect is respectfully requested.

Respectfully submitted,

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